G01R1/~~06B2~~ 07384

(12) UK Patent Application (19) GB (11) 2 014 315 A

(21) Application No 7903073
(22) Date of filing 29 Jan 1979
(23) Claims filed 29 Jan 1979
(30) Priority date
(31) 873584
(32) 30 Jan 1978
(31) 893118
(32) 4 Apr 1978
(33) United States of America (US)
(43) Application published 22 Aug 1979
(51) INT CL[2] G01B 7/00
(52) Domestic classification G1N 1A3B 3S1A 3V5 4A 4C 7H2 7N ACN H2E 26
(56) Documents cited
GB 1499003
GB 1436874
GB 1232175
GB 1147223
GB 1083381
GB 1040689
GB 872064
(58) Field of search
G1N
H2E

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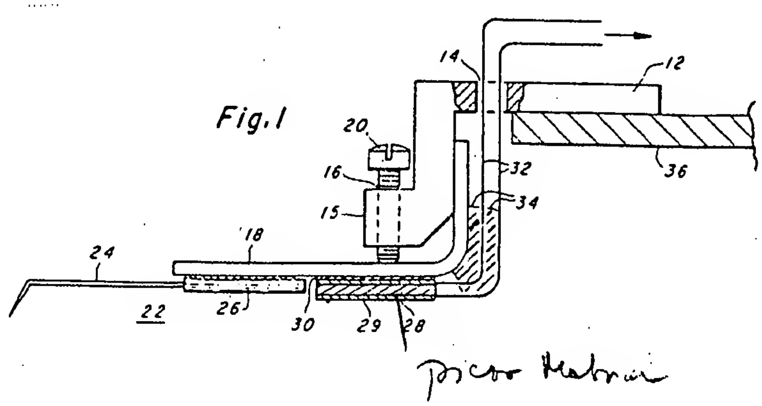
(54) Determining Probe Contact

(57) A probe for testing integrated circuit components includes a support body 12, and a conductive arm 18 supported and attached thereto in an angular fashion. A probe tip in the form of a needle 24 extends from and is attached to the conductive arm and has a downwardly positioned point for contact with a surface having integrated circuits thereon. A force sensitive material 28, e.g. piezoelectric, is attached to but electrically insulated from the conductive arm and has conductor leads 32 extending therefrom. The plane of the probe tip may be adjusted by screw 20. In addition, a multiprobe test system is disclosed for testing microcircuits which includes a printed circuit board having a plurality of data-detector probes attached for z-axis control and edge detection. A detector circuit having a plurality of channels receives signals delivered by the force sensitive material of each data-detector probe enabling the monitoring of planarization of the data-detector probe tips as well as controlling the over-travel of the probe tip into the surface having integrated circuits defined thereon. A method of using the multiprobe test system having a probe card with a plurality of data detector probes located thereon is also disclosed.

Fig. 1



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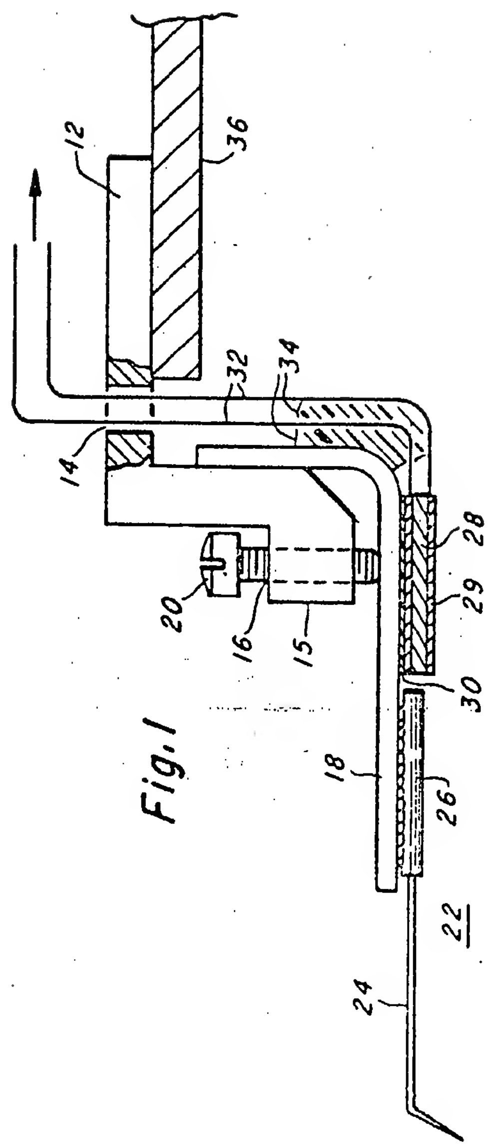


Fig.1

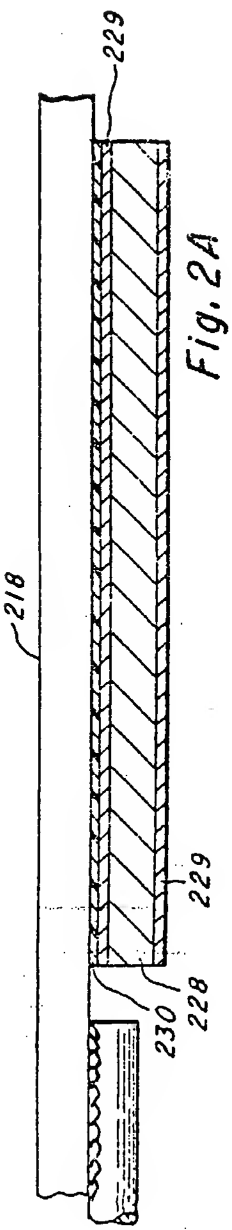


Fig. 2A

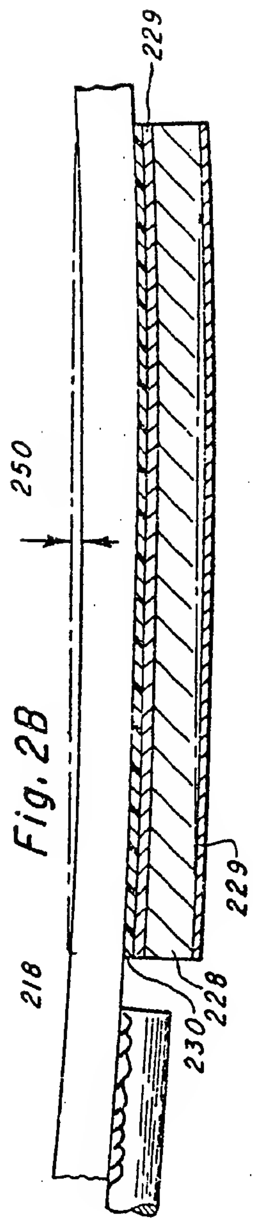
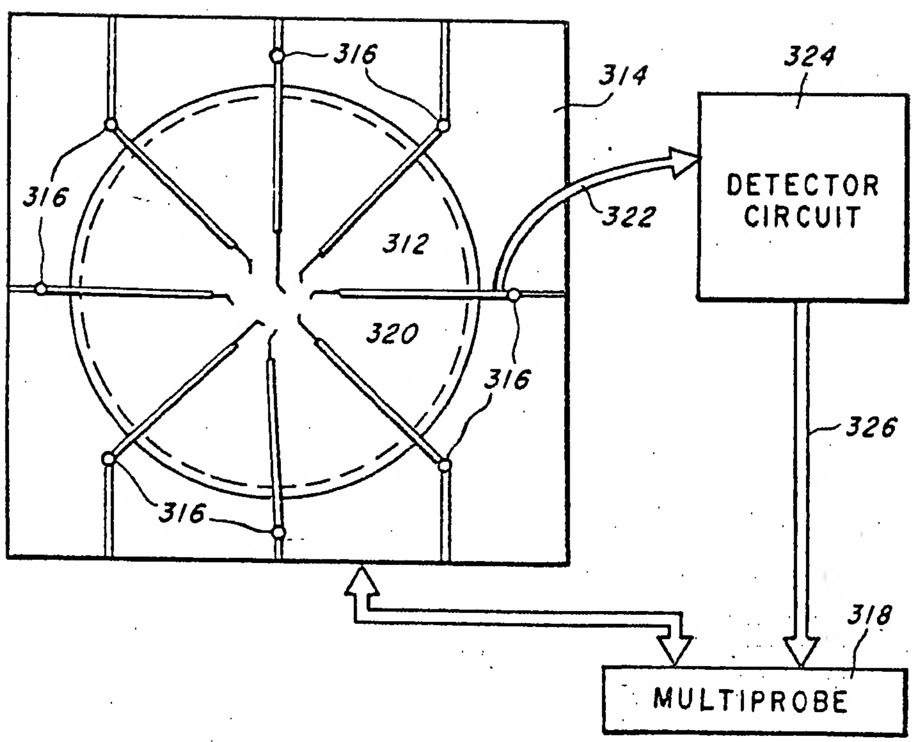


Fig. 2B

Fig. 3


316
314
324
316
DETECTOR
CIRCUIT
322
312
320
316
326
316
318
MULTIPROBE

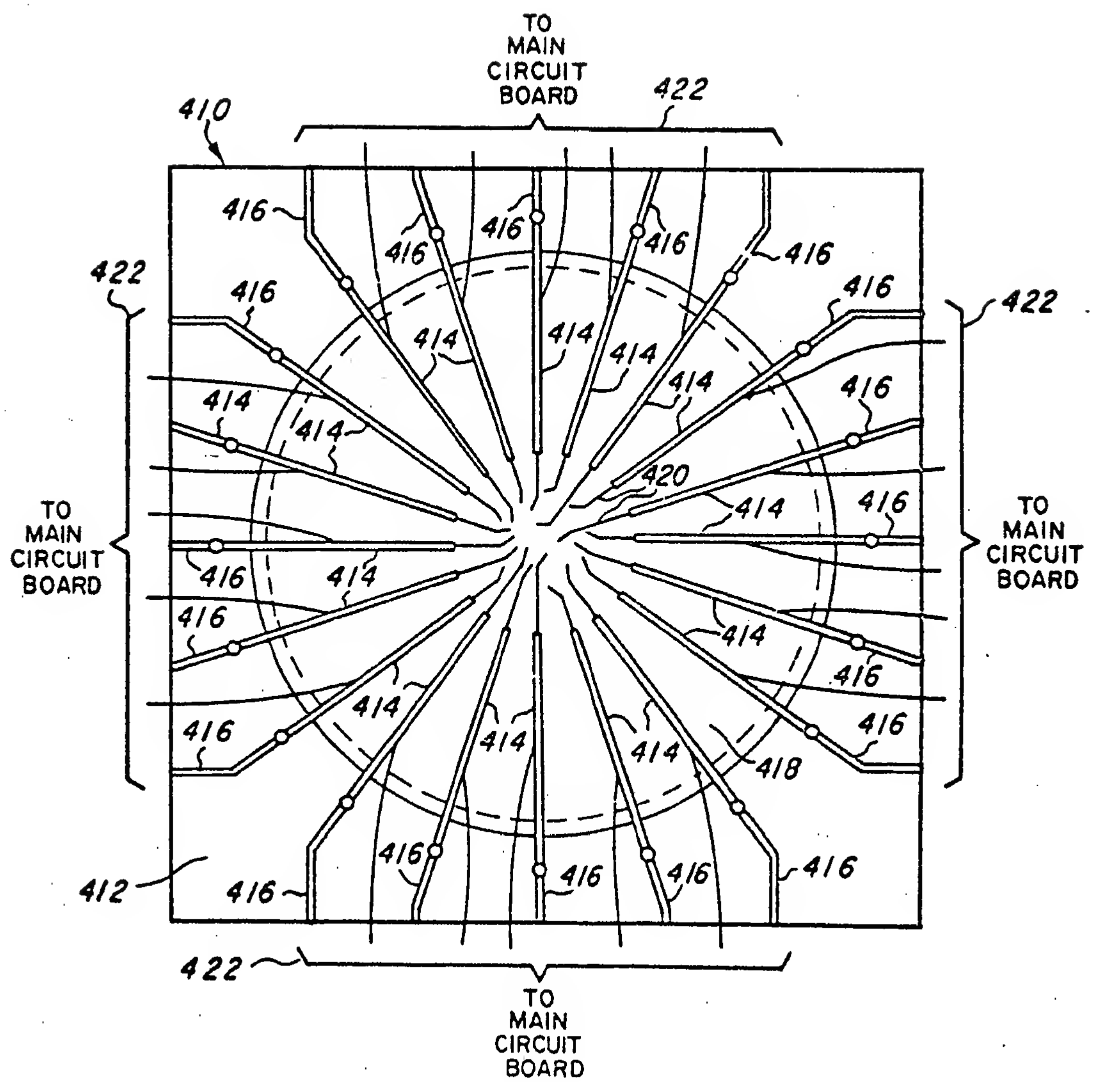

TO
MAIN
CIRCUIT
BOARD
422
410
416
414
420
418
412
TO
MAIN
CIRCUIT
BOARD
TO
MAIN
CIRCUIT
BOARD
TO
MAIN
CIRCUIT
BOARD

Fig. 4

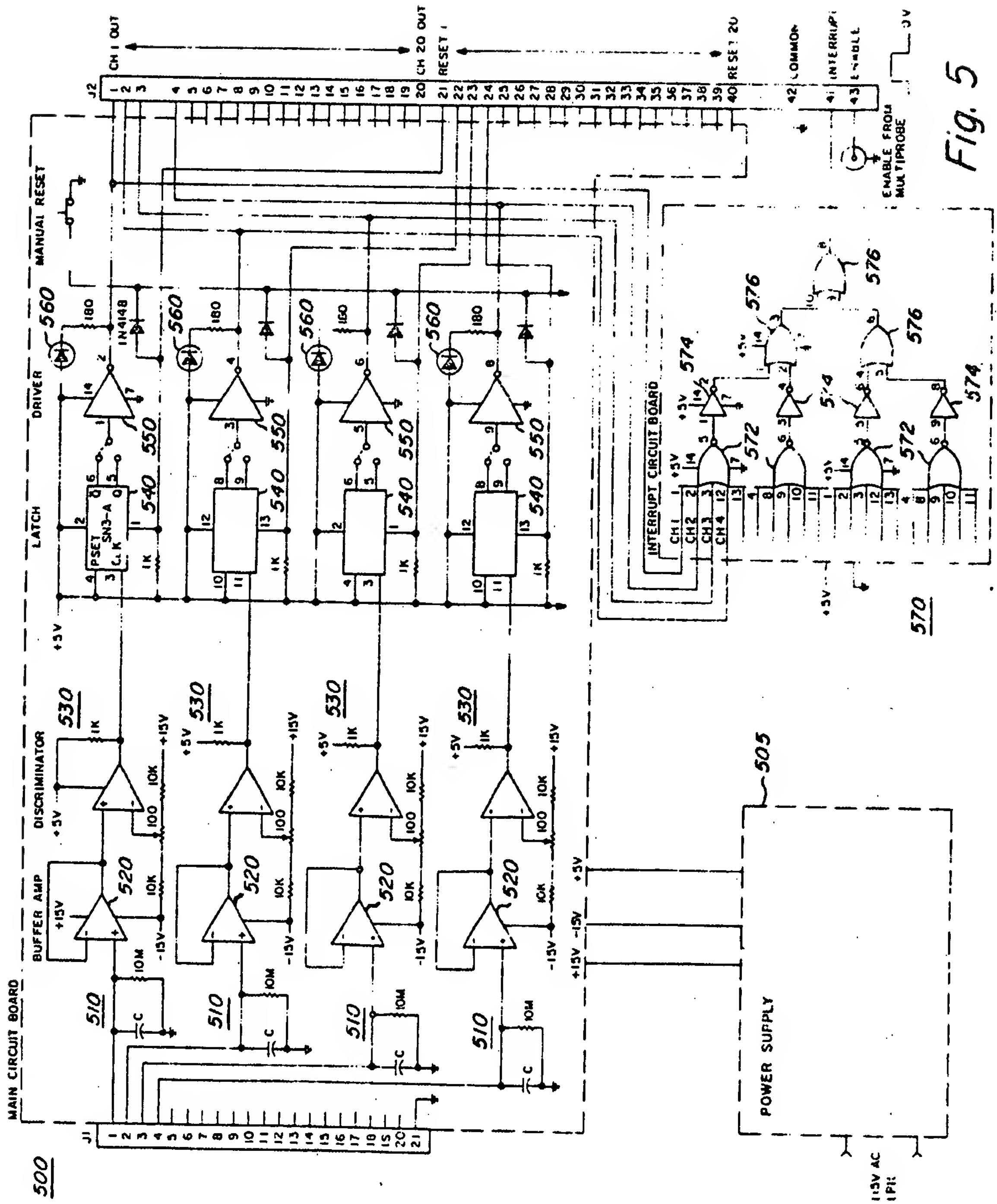

MAIN CIRCUIT BOARD
BUFFER AMP
DISCRIMINATOR
LATCH
DRIVER
MANUAL RESET
INTERRUPT CIRCUIT BOARD
POWER SUPPLY
CH 1 OUT
CH 20 OUT
RESET 1
RESET 20
COMMON
INTERRUPT
ENABLE
ENABLE FROM MULTIPROBE
115V AC
J1
J2
1N4148
500
505
510
520
530
540
550
560
570
572
574
576

Fig. 5

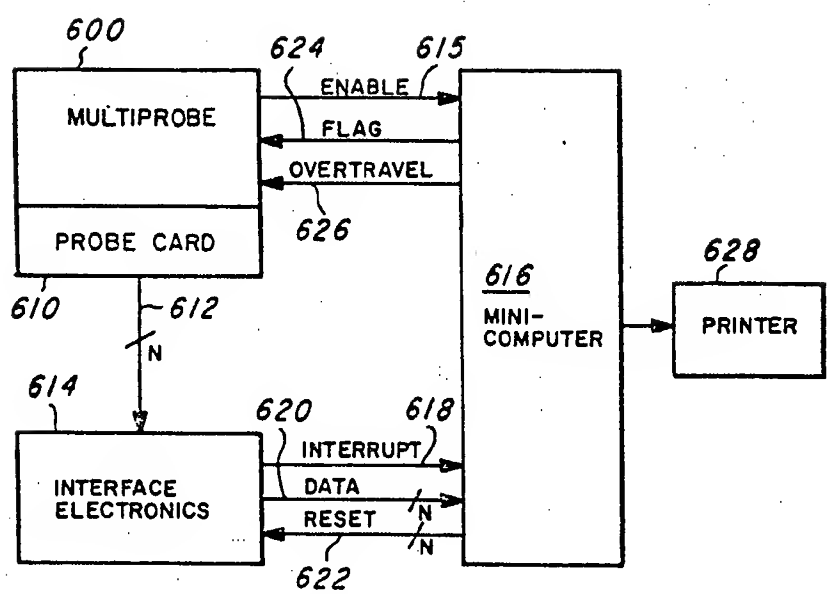

600
MULTIPROBE
PROBE CARD
610
612
N
614
INTERFACE ELECTRONICS
624
615
ENABLE
FLAG
OVERTRAVEL
626
616
MINI-COMPUTER
628
PRINTER
620
618
INTERRUPT
DATA
RESET
N
N
622

Fig. 6

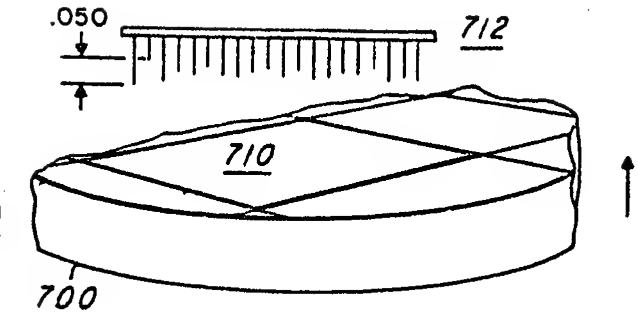


Fig. 7A

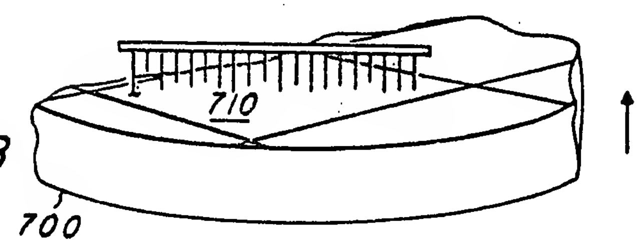


Fig. 7B

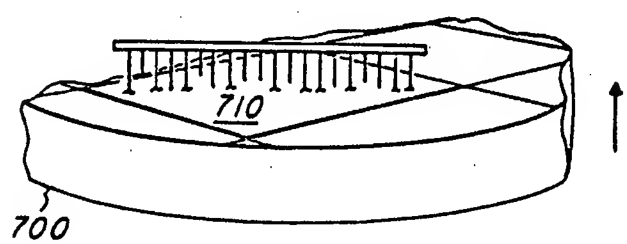


Fig. 7C

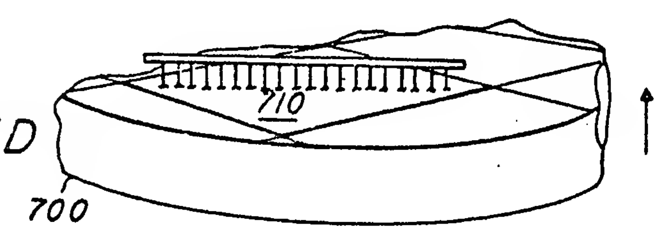


Fig. 7D

SPECIFICATION

Method and Apparatus for Determining Probe Contact

Background of the Invention

This invention relates to a probe device and more specifically to a probe device having a detector for sensing surface contact in the Z-axis and to a multiprobe test system having a plurality of such data-detector probes for sensing surface contact in the Z-axis detecting surface edges, enabling the monitoring of planarization and controlling over-travel into the surface of a semiconductor slice.

In the formation of electronic circuits, integrated circuits may be fabricated from thin semiconductor slices having a multiplicity of matrixes or microcircuits thereon. The general practice is for each slice to contain a multiple of identical repeating matrixes of the same type of micro-circuits. The individual unit or circuit is sometimes referred to as an integrated circuit chip or an individual bar.

Before distribution the present practice is to test each of the circuits of each integrated circuit chip on a slice or wafer prior to separating the slice into the desired integrated circuit components or combinations thereof.

Since each microcircuit or integrated circuit of each wafer is normally positioned in a predetermined precise relation with respect to adjacent circuit units, it is possible to test the circuitry if a probe can be accurately located on each preselected point that corresponds to the circuit to be tested. It is possible, for example, to test several different circuits at the same time on any one integrated circuit.

In the test procedure there are several obstacles to overcome in order to have reliable testing without damaging the slice. One of the difficulties experienced in the use of testing probes which include a supporting body having a needle connected thereto, is that the point of the probe tip may form a scratch on the surface of the semiconductor water as it is contacted by the point. This is caused by the lack of an effective Z-axis control. The Z-axis is the direction established by the vertical movement of the chuck or movable support of the semiconductor slice with respect to the probe tips. Among other things, the Z-axis control is needed to compensate for surface warpage of slices which may be as much as 5 mils across the surface of a large slice, determining the point of contact with the wafer, and in determining when the probe tips are off the slice i.e. edge detection.

Semiconductor slice testing is performed on a multiprobe machine such as the multiprobe manufactured by Electroglas Corp., Menlo Park, California model 1034X. The multiprobe machine contains a probe card which is a printed circuit board having attached thereto a series of data probes for injecting signals and collecting test data from the semiconductor slice. The present practice includes an edge sensor on the probe card which is in the form of a data probe having an electrical switch mechanism. Operationally the conventional edge sensor functions such that when the probe tip makes contact with the silicon slice an electrical open is caused. This open is detected by the multiprobe system and allows for a continuance of the testing procedures. When the chuck or support block for the semiconductor slice is vertically moved to make contact with the probe tips and no contact is detected by the edge sensor the open condition will not occur and the multiprobe system will perform an indexing procedure and move the slice such that the data probes are over the next row of integrated circuit chips. This conventional edge sensor has been found to be unreliable in the art and the cause of a significant amount of down time of the multiprobe system and damage to chips which results when the chuck is continuously moved upward and probe tip contact is not identified. After the probe tips make contact with the slice it is necessary for the chuck to move an additional 1—5 mils of overtravel in order to break through the oxide layer and make good electrical contact with the active circuit elements, a technique called scrub-in. If the probe contact with the slice is not identified the overtravel cannot be controlled and the result is probe tip breakage, excessive overtravel, which damages chips, and machine down time.

A further problem found in multiprobe test systems is the fact that the nature of the semiconductor slice is such that the integrated circuits defined thereon are in a patterned series of chips which may be rectangular in geometry. Due to the circular nature of the semiconductor slice there results a series of partial integrated circuit chips on the edges of the semiconductor slice. The use of a single edge sensor will identify approximately half of the partial bars as a surface to be tested and the result is that the multiprobe system will attempt to test these partial bars, wasting time, identifying the partial bars to be a bad circuit, and thereby inking the partial bar for identification. The same problem is encountered in testing a broken semiconductor slice which gives rise to an even increased number of partial bars making edge detection of even greater importance.

Summary of the Invention

In accordance with the present invention it is proposed to utilize a conventional data probe having a support body, an arm connected to the support body and extending therefrom in an angular fashion and having a probe tip connected to the arm with an adjusting mechanism, such as a screw for changing the plane of the probe tip. The data probe performs as an edge sensor when a detector comprising a force sensitive material such as lead zirconate—lead titanate (ZT), for example, is bonded to the arm and is mechanically deformed when the probe tip makes contact with a surface such as a semiconductor slice. The detector then delivers an electrical

signal by way of conductor leads to an interface circuit and thence to the multiprobe system signifying that the probe tip has made contact with an integrated circuit.

The data probe having a detector attached thereto is further connected to a probe card or printed board along with a plurality of data probes for testing the semiconductor slice. The Z-axis signal received by the multiprobe system that the detector probe has made contact with the surface of the semiconductor slice allows the multiprobe system to move a chuck support a fixed distance in the Z-axis to insure total data probe contact and proper scrub-in.

Further in accordance with the present invention, it is proposed to locate a plurality of data-detector probes on an electrical support as, for example, a printed circuit board. The data-detector probes are physically and electrically connected to the printed circuit board with each of the plurality of data-detector probes comprising a support body, an arm connected to the support body and extending therefrom in an angular fashion. The probe tip is connected to the arm with an adjusting mechanism, such as a screw, for changing the plane of the probe tip. The data-detector probe performs as a data probe and as a Z-axis detetector when a force sensitive material such as lead zirconate-lead titanate (PZT), for example, is bonded to the arm and mechanically deformed when the probe tip makes contact with a surface such as semiconductor slice. By designating the Z-axis sensing assembly to have a plurality of data-detector probes rather than simply a plurality of data probes and several edge sensing probes, it is possible to monitor the Z-axis contact of each and every data-detector probe upon contact with the semiconductor slice. The signals generated by the force sensitive material on each of the data-detector probes is delivered to a detector circuit which in turn will deliver relevant information to a multiprobe device and/or a minicomputer for evaluation of the timing of the data-detector probe contact with the semiconductor slice to provide effectlve monitoring of the Z-axis movement which will result In effective monitoring of planarization, control of overtravel, probe tip contact identification, and edge sensing.

In a method for testing integrated circuits utilizing a Z-axis detector assembly unit having a plurality of data-detector probes placed on an electrical support means in spaced parallel relation to a semiconductor slice, the data-detector probe tips must first be initialized by assuring that the probe tips all lie in the same plane (i.e. planarizing). After initialization the movable support means supporting the semiconductor slice must be raised in order to make contact with the plurality of data-detector probes. A minicomputer may be utilized to count the data-detector probes as they make contact with the semiconductor slice based upon the information received from a detector circuit receiving signals from the force sensitive materials of each of the data-detector probes. Planarization may be monitored based on this information by starting a clock upon first contact of the semiconductor slice by one of the plurality of data-detector probes and stopping the clock upon receiving a signal that all of the plurality of data-detector probes have made contact with the semiconductor slice. Planarization may then be determined by calculating the distance between the first data-detector probe to make contact with the semiconductor slice and the last data-detector probe to make contact with the semiconductor slice considering the number of clock cycles elapsed between the first contact and last contact and the speed of the semiconductor slice approaching the plurality of data-detector probes. Subsequent to monitoring planarization of the data-detector probe tips overtravel into the semiconductor slice may be controlled by initializing the movable support of the semiconductor slice to travel predetermined distance in the Z-axis to enable the data-detector probe tips to scrub-in a fixed distance into the semiconductor slice only after the planarization of the data-detector probe tips has been checked and found to fall within a predetermined set limit of planarization. Testing of the integrated circuit chips found on the semiconductor slice may then be performed by delivering test signals by way of the data-detector probes into the integrated circuit chip and evaluating those signals.

Brief Description of the Drawings

Figure 1 is a diagrammatic side view of a probe detector device in accordance with the present invention;

Figure 2a is a partial side view of the probe detector in Figure 1 illustrating the force sensitive material attached thereto;

Figure 2b is a partial side view of the probe detector device shown in Figure 1 and further demonstrates the force sensitive material in a deflected state;

Figure 3 is a multiprobe system shown partially in a diagrammatic view and partially in block diagram illustrating the use of a probe detector device in accordance with the present invention.

Figure 4 is a top view of a probe card assembly having a plurality of data-detector probes as shown in Figure 1 attached thereto in accordance with the present invention;

Figure 5 is a partial block diagram and partial circuit schematic illustrating a detector circuit to be used in a multiprobe test system in accordance with the present invention;

Figure 6 is a block diagram illustrating a multiprobe test system using the probe card assembly of Figure 4, the data-detector probe illustrated in Figure 1, and the detector circuit illustrated in Figure 5; and

Figures 7A—7D are diagrammatic perspective views of the probe card assembly and a movable support block supporting a semiconductor slice in accordance with the present invention

Detailed Description of the Drawings

Referring now to the drawings and more particularly to Figure 1 where a probe detector device 10 is illustrated. The probe device 10 is structured as a data probe having the functional characteristic of employing Z-axis control in determining when contact is made to a semiconductor slice. The probe may be attached to a printed circuit board located in parallel relation to the semiconductor slice, as shown in Figure 3 and described hereinafter.

Structurally, the probe 10 comprises a support body 12 having first and second apertues 14 and 16 respectively. The support body 12 may be an L-shaped structure where the first aperture 14 is located on the long side of the L and the second aperture 16 located in the flange 15 of the short side of the L shaped structure 12. The support body 12 may be of a conductive material as brass for example and further may be gold plated.

An arm 18 is attached to the support body 12 and is extended therefrom. The extended arm may also have an L-shaped structure such that the short section of the L-shaped arm is attached to the short section of the L-shaped support structure 12. The extended arm may also be of a conductive material such as brass and also may be gold plated.

An adjusting screw 20 located within said second aperture 16 found in the support structure 12 extends through to the extended arm 18.

A test needle assembly or probe tip assembly 22 having a needle or probe tip 24 and a support sleeve 26 is attached to the extended arm 18. The needle 24 is utilized to contact the semiconductor slice having integrated circuits thereon such that relevant electrical data signifying the usefulness of the particular integrated circuit chip may be obtained. This is the main function of the needle 24 when utilized as a data probe.

In order to sense Z-axis contact, that is that point in time when the test needle 24 has made contact with a semiconductor surface, a force sensitive material 28 may be attached to the extended arm 18 of the test probe detector device 10. The force sensitive material is bordered by silver plated regions 29. In order to insulate the force sensitive material 28 from the conductive properties of the remainder of probe device 10 the silver plates 29 of the force sensitive material 28 may be attached to the extended arm 18 by an insulating epoxy material 30. The force sensitive material 28 may comprise a piezoelectric substrate or monomorph or a piezoelectric sandwich type structure called a bimorph. Characteristics of the piezoelectric material are such that it may perform as a generator. This characteristic is such that when the piezoelectric material is deformed or flexed a voltage is generated by the material itself. A pair of lead wires or conductors 32 are soldered to the silver plates 29 of the force sensitive material 28. Thus, if a piezoelectric material were used as a force sensitive material 28, upon deforming a voltage will be generated and sensed across lead wires 32. Lead wires 32 are insulated from each other. Each lead wire is covered with a conforming insulation and extended up through the first aperture 14 found in the support body 12 of the probe detector test structure 10. The signal is then delivered to a detector circuit not shown. The lead wires 32 may be bonded to arm 18 by an epoxy 34.

The entire Z-axis detector may be attached to a printed circuit board such that the long section of the L-shaped support body 12 is attached to the printed circuit board 36 as shown in Figure 1.

Figures 2a and 2b illustrate deflection characteristics of the piezoelectric material 28 of Figure 1. In Figure 2a a partial side view of Figure 1, the piezoelectric material 228, having silver coating 229 is bonded to a conductive bar 218 by way of an insulating matter 230, as for example an epoxy material, is illustrated in its rest or rigid position in a horizontal plane. Figure 2b demonstrates deflection characteristics of the piezoelectric material 228 which occur when the bar 218 is deformed as the downward displacement shown in Figure 2b which results in a deflected distance 250. The deflection of the force sensitive material 28 found in Figure 1 is due to the test needle, 24 in Figure 1, coming in contact with a surface and having a force directed in the upward vertical direction.

Referring now to Figure 3 a probe detector device for Z-axis control is illustrated in a multiprobe test system 310. The multiprobe test system 310 includes a semiconductor slice support 312 known in the art as a chuck. The chuck 312 is located in parallel relationship to a printed circuit board or probe card 314. The printed circuit board 314 may be of the type manufactured by Teledyne TAC, California. Attached to the probe card 314 are a plurality of data probes 316. The data probes 316 monitor the electrical characteristics of the integrated circuits found on the semiconductor slice located on the chuck 312. These electrical characteristics are monitored and evaluated by multiprobe 318 electrically connected to the probe card 314.

In addition to the plurality of data probes 316, a probe device in accordance with the present invention taking the form of the probe device 10 illustrated in Figure 1 is also attached to the probe card 314. The probe tested 320 having a force sensitive element not shown in Figure 3 but similar to the force sensitive material 28 illustrated in Figure 1 may be utilized for Z-axis control and further as an edge detector. The signal generated by a deflection of the force sensitive material is delivered by way of conductor 322 to a detector circuit 324 which is used to amplify, condition, and provide suitable output signals compatible with the multiprobe where the detector circuits output is either in the form of a TTL-compatible pulse or DC-level signifying probe contact. This signal is then delivered by way of an electrical connection 326 to the multiprobe 318.

The data probe 316 may be a model 13742—

11 sold and manufactured by Teledyne of California.

Operationally when utilized as a Z-axis control the multiprobe 318 will direct the chuck 312 to move in a direction parallel to the probe card 314 until such a point in time where the probe device 320 makes contact with the semiconductor slice on the chuck 312 thus deforming the force sensitive material found on probe 320 in such a way as to generate a signal which is transferred over conductor 322 to detector circuit 324 and ultimately to the multiprobe 318 which halts the movement of the chuck 312 in the direction of the probe card 314. This form of Z-axis control is utilized in probing every independent integrated circuit found on the semiconductor slice. The probe detector 320 may also be utilized in place of a conventional edge sensor in detecting when the testing of a row of integrated circuits on a semiconductor slice is complete, that is when no contact is detected the multiprobe 318 will cause an indexing sequence to occur in order to enable the testing of a subsequent row of integrated circuits on the semiconductor slice.

Referring now to Figure 4, a probe card assembly 410 is illustrated. The probe card assembly 410 is structured such that a printed circuit board 412 is used to support a plurality of data-detector probes 414, electrically connected to the printed circuit board 412 by leads 416. Leads 416 provide the electrical means for transmitting and receiving signals between the plurality of data-detector probes 414 and a multiprobe device or minicomputer (not shown) for purposes of testing a semiconductor slice. The data-detector probes 414 are shown in Figure 4 as being located in spaced parallel relation to a semiconductor slice surface 418, each of the plurality of data-detector probes 414 has connected thereto a force sensitive material (not shown) as illustrated in previously described Figures 1, 2A and 2B, which recognizes contact in the Z-axis of the probe tips 420 to the semiconductor slice surface 418. This detector in the Z-axis is signaled to a detector circuit, illustrated in Figure 5 and described hereinafter, by way of lead wires 422.

Referring now to Figure 4 and 5, a probe card assembly 410 (Figure 4) described above and a detector circuit 500 are illustrated. Each data-detector probe 414 has a dual function of providing a signal for Z-axis contact and delivering test signals to and from the integrated circuit chips. Lead wires 422 extending from the data-detector probes 414 electrically connect the Z-axis detector 410 to a detector circuit 500. The detector circuit board 500 demonstrates four independent detector channels to be used by one of the plurality of data-detector probes 414. A power supply 505 is utilized to provide a ±15 volt and +5 volt power source to the detector circuit 500. Each channel comprises an RC filter assembly 510 electrically connected to a unity gain buffer amplifier 520 where the RC filter 510 filters noise spikes and dampens response time of the voltage signal received from the data-detector probes 414. The unity gain buffer amplifier 520 transforms the voltage signal from a high impedance signal to a low impedance signal. The unity gain buffer amplifier may be of the type made and manufactured by Texas Instruments Incorporated, Dallas, Texas model TL084N. This low impedance signal is then delivered to a level discriminator assembly 530. The level discriminator assembly 530 is of the threshold level type whereby unless the signal reaches a predetermined threshold voltage, for example, 30 millivolts, the low impedance signal will not be recognized and essentially blocked. If, however, the low impedance signal is above the threshold limit the discriminator output will be set to the maximum voltage, as, for example, the 5 volts found in the Figure 5 circuit. The level discriminator may be the type made and manufactured by Texas Instruments Incorporated, Dallas, Texas model LM339N. After discriminating against low level noise signals the desired signal at a nominal 5 volts voltage level is delivered to a latch circuit 540 which latches the signal to, for example, a 0 voltage and delivers that signal to a buffer/driver 550. The buffer/driver 550 provides the necessary power to enable the light emitting diode 560 as well as provide signals to the computer and the interrupt circuit board 570. The latching circuit may be of the type made and manufactured by Texas Instruments Incorporated, Dallas, Texas, model 7474N, while the buffer/driver may be of the type made and manufactured by Texas Instruments Incorporated, Dallas, Texas model 7507N. The latch signal is delivered to an interrupt circuit 570 and may be grouped in units of 4, for example, and delivered to a series of "NAND" gates 572 followed by an inversion of the signals by inverters 574, and finally channeled to a series of positive "AND" gates 576. The NAND gates 572, inverter-buffer driver 574 and the "AND" gates 576 may also be of the type made and manufactured by Texas Instruments Incorporated, Dallas, Texas models 74S260N, 7404N, and 7432N, respectively. If all of the data-detector probes 414 contact the semiconductor surface 418, an output interrupt signal will be delivered to a multiprobe unit or minicomputer (not shown). If, however, any one of the inputs to the "NOR" gate fails to go "high", for example, that will indicate that one or more of the data-detector probes 414 has not made contact with the semiconductor slice 418 and a data-detector probe failure or edge condition is present. This interrupt state can cause the multiprobe to index and begin testing a new row of integrated circuit chips. When an interrupt condition occurs the minicomputer will send a reset signal back to the latch circuit 540 to reset the latch to its predetermined state in preparation for the next chip to be tested.

Referring now to Figure 6 in conjunction with Figures 4, 5 and 7A—7D a multiprobe test system 600 is illustrated. A multiprobe such as

the multiprobe system made and manufactured by Electroglas Corp., Meno Park, California, model 1034X is utilized with a probe assembly 610 such as the probe assembly illustrated in Figure 4 of the drawings to provide signal information by way of a plurality of data lines 612 to interface electronics 614 which may be in the form of the 20 channel detector circuit 500 illustrated in Figure 5 and described above. The multiprobe 600, and the interface electronics 614 are electronically connected to a minicomputer such as the minicomputer made and manufactured by Texas Instruments Incorporated, Dallas, Texas, model TI/960. The multiprobe device will deliver an enable signal 615 to the minicomputer 616 to initiate test procedures for a semiconductor slice 418 and the interface electronics 614 will deliver a interrupt signal 618 and data 620 to the minicomputer 616 for evaluation of the data-detector probes 414 Z-axis contact with a semiconductor slice 418. The minicomputer 616 will then deliver a reset signal 622 to the channels of the interface electronics 614 resetting the latch circuit 540 as was described with respect to Figure 5.

Referring now more specifically to Figures 6 and 7A—7D, in Figures 7A—7D the movement of a programmable movable support 700 supporting a semiconductor slice 710 progressing in the Z-axis toward a plurality of data-detector probe tips 712 is shown.

In a method for utilizing the multiprobe system illustrated in Figure 6, the data-detector tips 712 are first initialized by adjusting the data-detector probe tips to be in the same plane within .5 mils, for example. The multiprobe device 600 utilizes a programmable movable support 700 which supports a semiconductor slice 710 having a plurality of integrated circuit chips thereon. The movable support 700 progresses in the Z-axis toward the plurality of data-detector probe tips 712 whereupon the first data-detector probe tip making contact with the surface 710 the interface electronics 614, which as stated above, may be in the form of detector circuit as illustrated in Figure 5, receives a voltage signal from the force sensitive material on the data-detector probe making contact with the surface 710. This signal is transmitted to the minicomputer 616 over the data line 620 informing the minicomputer 616 that one or more data-detector probe tip contacts have been made and to start a clock running at the time of contact. Based upon a predetermined number of data-detector probes present in the system and said number stored in the computer the minicomputer 616 will monitor the number of data-detector probes making contact with the surface 710 until all data-detector probes have made contact. However, if there is a data-detector probe failure or an edge condition exists, the predetermined number of data detector probes will not be reached. A predetermined clock cycle limit which represents distance is stored in the minicomputer to prevent probe tip breakage from excess overtravel. If this number is exceeded, the minicomputer 616 will then generate a flag signalling the multiprobe 600 to stop the movable support. This signal is sent by way of data line 624. If the number of data-detector probes making contact agrees with the predetermined number of probes placed in the minicomputer system 616, upon receiving a signal that the last data-detector probe has made contact the clock will stop and based upon the speed of the movable support and the number of clock cycles between the first data-detector probe making contact with the semiconductor 710 and the last data-detector probe making contact with the semiconductor slice 710 a calculation is made to determine if the distance between the first and last data-detector probes making contact is within acceptable tolerance when compared to a planarization limit of approximately 0.5 mils. Thus, monitoring planarization is accomplished to assure that no one data-detector probe will scrub into the semiconductor surface 710 such that the probe tip, or bar, will be damaged causing machine downtime and loss of product. Also, upon receiving a signal that the last data-detector probe tip has made contact with the semiconductor slice 710 the minicomputer will send a signal by way of data line 626 to the multiprobe instructing the multiprobe device 600 to move the movable support a fixed distance for overtravel of the data-detector probe tips into the semiconductor surface 710, i.e. scrubbing in the tip through the oxide layer of the semiconductor slice 710 to make good electrical contact. This overtravel distance is adjustable and may be on the order of 2—5 mils. Thus, the recognition of the time elapsed between the first data-detector probe making contact with the semiconductor slice 710 and the last data-detector probe making contact with the semiconductor slice enables the monitoring of the planarization of the data-detector probe tips and further enables the control of the overtravel of the data-detector probe tips into the semiconductor surface 710.

After completing the current test and prior to starting the next test the minicomputer 616 delivers a reset signal to the interface electronics 614 to reset to the latch circuit to prepare for the next test of integrated circuits. Further, test signals are delivered to the semiconductor slice integrated circuits by way of the data-detector probes for determining if the integrated circuit chips are operable. All information concerning data-detector probe failure, or edge condition or test status is finally delivered to a terminal printer 628 for user interface. The terminal printer may be of the type manufactured by Texas Instruments Incorporate, Dallas, Texas, model 700.

While the present invention has been described and illustrated with specific embodiments, it should be apparent to those skilled in the art that various modifications may be made without departing from the spirit and scope of the present invention.

Claims

1. A probe for testing integrated circuits comprising: a support body;

an arm connected to said support body and extending therefrom in an angular fashion;

a probe tip having an angular point connected to said arm and extending therefrom;

adjustable means attached to said support body and operatively associated with said arm for altering the plane in which said probe tip lies; and

detector means comprising a force sensitive material bonded to said arm for sensing when said probe tip makes contact with a surface having an integrated circuit defined thereon.

2. A probe as set forth in Claim 1 wherein said support body comprises a conductive material.

3. A probe as set forth in Claim 2 wherein said conductive material comprises a gold plated brass body.

4. A probe as set forth in Claim 1 wherein said adjustable means comprises an adjustment screw.

5. A probe as set forth in Claim 1 wherein said force sensitive material comprises a piezoelectric material.

6. A probe as set forth in Claim 5 wherein said piezoelectric material is lead zirconate—lead titanate.

7. A probe as set forth in Claim 1 wherein said arm comprises a conductive material.

8. A probe as set forth in Claim 1 further including conductor leads attached to said force sensitive material for delivering data signifying contact between said probe tip and said integrated circuit.

9. A probe as set forth in Claim 1 wherein said probe tip comprises a conductive needle.

10. A multiprobe test system for testing microcircuits comprising:

movable support means for locating a semiconductor slice having a plurality of integrated thereon;

a printed circuit board located in parallel spaced relation to said movable support means;

a plurality of data probes connected to said printed circuit board for testing said integrated circuits;

a detector probe attached to said printed circuit board between data probes including

a support body,

an arm connected to said suport body and extending therefrom in an angular fashion,

a probe tip having an angular point connected to said arm and extending therefrom,

adjustable means attached to said support body and operatively associated with said arm for altering the plane in which said probe tip lies, and

detector means comprising a force sensitive material bonded to said arm for sensing when said probe tip makes contact with said semiconductor surface having an integrated circuit defined thereon,

a detector circuit electrically associated with said detector probe for delivering an electrical signal signifying that the detector probe has made contact with said semiconductor slice; and

means for evaluating signals received from said data probes and said detector circuit.

11. A multiprobe test system as set forth in Claim 10 wherein said movable support means comprises a chuck support.

12. A Z-axis detector assembly comprising:

electrical support means; and

a plurality of data-detector probes located on said electrical support means for detecting a semiconductor surface having a plurality of integrated circuit chips disposed thereon and testing said integrated circuit chips.

13. A Z-axis detector assembly as set forth in Claim 12, wherein each of said data-detector comprise:

a support body,

an arm connected to said support body and extending therefrom in an angular fashion,

a probe tip having an angular point connected to said arm and extending therefrom,

adjustable means attached to said support body and operatively associated with said arm for altering the plane in which said probe tip lies, and

sensing means comprising a force sensing material bonded to said arm for sensing when said probe tip makes contact with said surface.

14. A Z-axis detector assembly as set forth in Claim 13, wherein said force sensitive material comprises a piezoelectric material.

15. A Z-axis detector assembly as set forth in Claim 12 or 13, wherein said electrical support means comprises a printed circuit board.

16. A multiprobe test system for testing microcircuits comprising:

movable support means for locating a semiconductor slice having a plurality of integrated circuits thereon;

electrical support means located in parallel spaced relation to said movable support means;

a plurality of data-detector probes electrically connected to said electrical support means for detecting the surface of said semiconductor slice each of said plurality including:

a support body,

an arm connected to said support body and extending therefrom at an angular fashion,

a probe tip having an angular point connected to said arm and extending therefrom,

adjustable means attached to said support body and operatively associated with said arm for altering the plane in which said probe tip lies, and

sensing means comprising a force sensitive material bonded to said arm for sensing when said probe tip makes contact with said semiconductor slice,

detector circuit means electrically associated with and connected to said data-detector probes for delivering an electrical signal signifying that said data-detector probes have beem made contact with said semiconductor slice; and

means for evaluating signals received from said detector circuit means.

17. A multiprobe test system for testing microcircuits as set forth in Claim 16, further

including system output means electrically connected to said means for evaluating and operatively associated therewith for displaying said detector circuit means signals.

18. A multiprobe test system for testing a group of microcircuits as set forth in Claim 17, wherein said detector circuit means comprises a multichannel circuit wherein each channel includes:

filtering means for reducing noise from a signal delivered from said force sensitive material,

amplifier circuitry electrically connected to said filter means for transforming the impedance of said signal,

electronic discriminator means for screening spurious signals such that only signals above a fixed threshold voltage will detect, said discriminator means being electrically connected to said amplifier circuitry,

latch circuit means for latching said signal, and

buffer driver means for boosting the power of said signal and delivering an output signal to said means for evaluating signals.

19. A multiprobe test system for testing microcircuits as set forth in Claim 18, further including a light emitting diode element in each of said channels electrically connected to said buffer driver means for displaying said data-detector signal signifying that said data-detector has made contact with said semiconductor slice surface.

20. A multiprobe test system as set forth in Claim 19, further including interrupt circuit means for summing said data-detector probe signals and delivering an interrupt signal to said means for evaluating said signals.

21. A multiprobe test system as set forth in Claim 20, wherein said interrupt circuit means comprises a series of "NOR" gates for receiving said buffer/driver signal with each of said "NOR" gates delivering a signal to an inverter which is then summed by a series of "OR" gates and delivered to said means for evaluating said signals for determining if all data-detector probes made contact with said semiconductor slice surface.

22. A method for testing Integrated circuits disposed on a semiconductor slice using plurality of data-detector probes, located on an electrical support placed over said semiconductor slice in spaced parallel relation, and computational evaluation means comprising the steps of:

planarizing said data-detector probes on said electrical support such that all data-detector probes lie in the same plane;

raising said semiconductor slice in the Z-axis to make contact with said plurality of data-detector probes;

counting data-detector probes as they make contact with said semiconductor slice;

monitoring planarization of said data-detector probes throughout testing;

controlling overtravel of said data-detector probes into said semiconductor slice; and

delivering test signals between said calculating evaluation means and said integrated circuit chips.

23. A method for testing semiconductor slices according to Claim 22, wherein said step of monitoring planarization includes:

starting a clock upon first contact of said semiconductor slice surface with one of said plurality of data-detector probes,

stopping said clock upon receiving a signal that all of said plurality of data-detector probes has made contact with said semiconductor slice;

calculating the distance between the first of said plurality of data-detector probes making contact with said semiconductor slice and the last of said plurality of data-detector probes making contact with said semiconductor slice considering the number of clock cycles and the speed of the semiconductor slice approaching said plurality of data-detector probes; and

comparing the calculated distance between said first and said last of said data-detector probes making contact with said semiconductor slice with a predetermined planarization limit.

24. A method of testing a semiconductor slice as set forth in Claim 22 or 23, wherein the step of controlling overtravel includes:

raising said semiconductor slice at a predetermined rate for a fixed number of clock cycles after the last data-detector probe makes contact with said semiconductor surface, thereby scrubbing the data-detector probes into the surface of said semiconductor slice thereby enhancing electrical contact to the said integrated circuits.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1979. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.